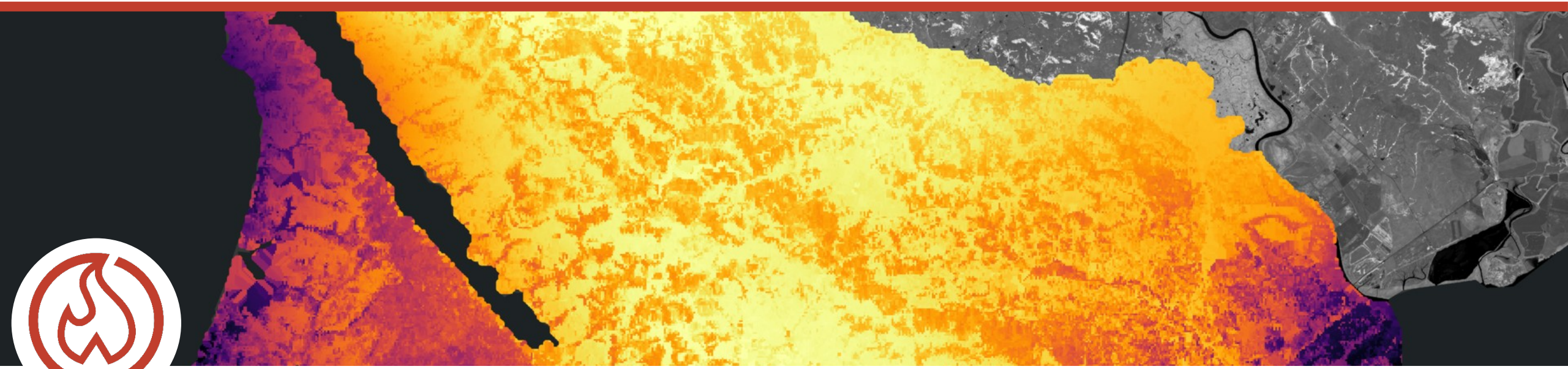
National Aeronautics and Space Administration



Marin County Wildland Fires

Examining Fuel Load and Land Cover Change to Inform Fire Prevention and Suppression Decisions in Marin County, CA

Suhani Dalal Katera Lee Chandler Ross Gabriel Rosenstein

25TH DEVELOP ANNIVERSARY

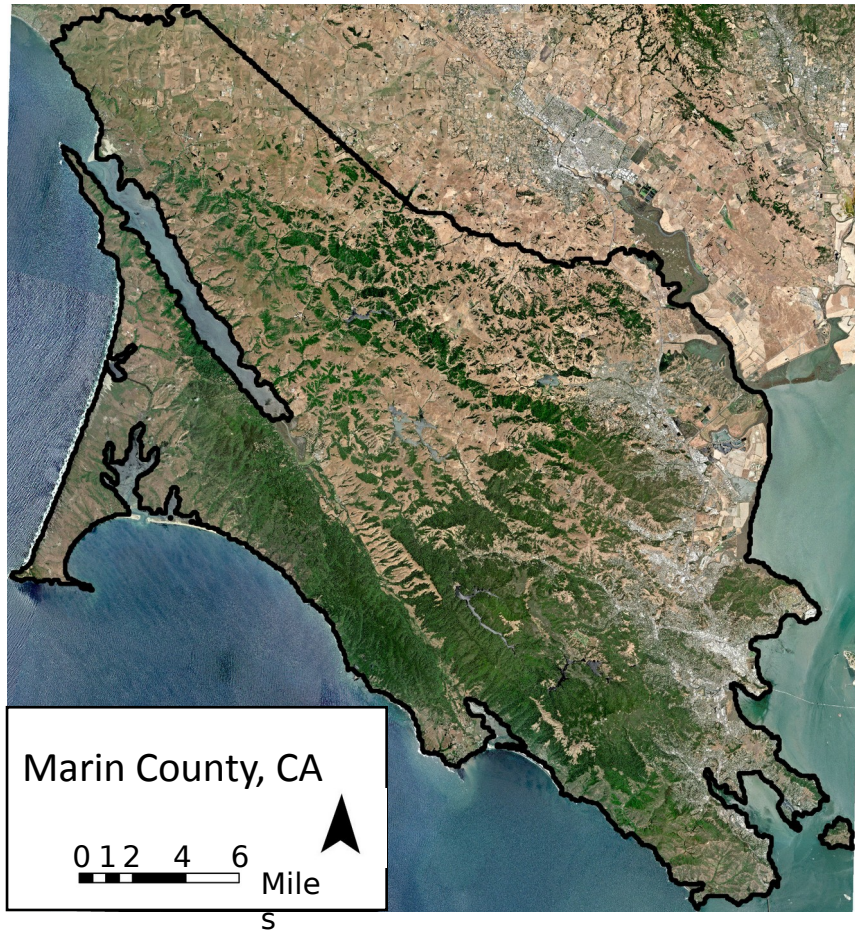
Marin County, CA

Marin County

Located between the Pacific Ocean and the San Francisco Bay, directly north of San Francisco

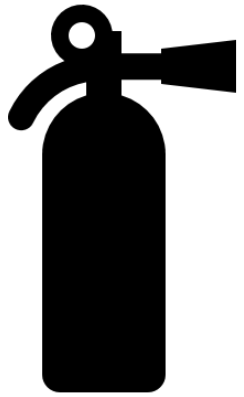
Study Period

May – November; 2018 – 2022

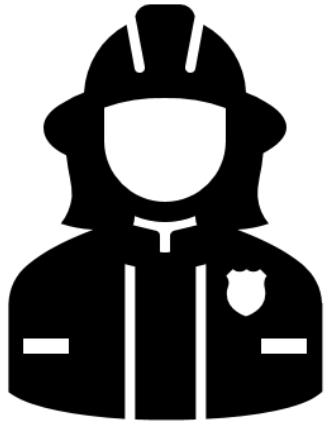


Basemap: 2022 PlanetScope Imagery

Project Partners



Marin County Fire Department



FIRE Foundry

Community Concerns

- People in surrounding areas are at **higher risk**
- Proximity to infrastructure damage
- **Destruction** of natural areas

Source: Tony Webster, Wikimedia Commons

Objectives

Fuel Load Maps

Use various vegetation indices to determine the load and density of fuel for wildfires

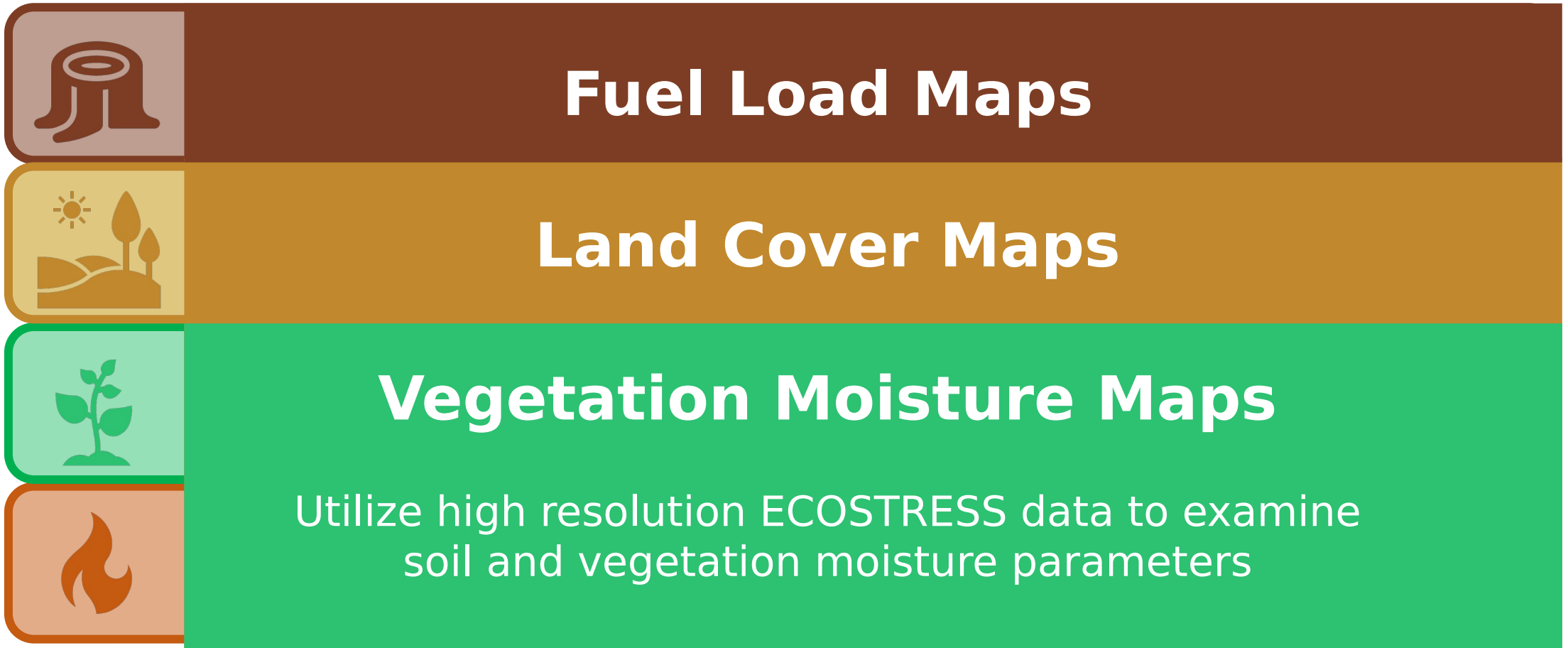
Objectives

Fuel Load Maps

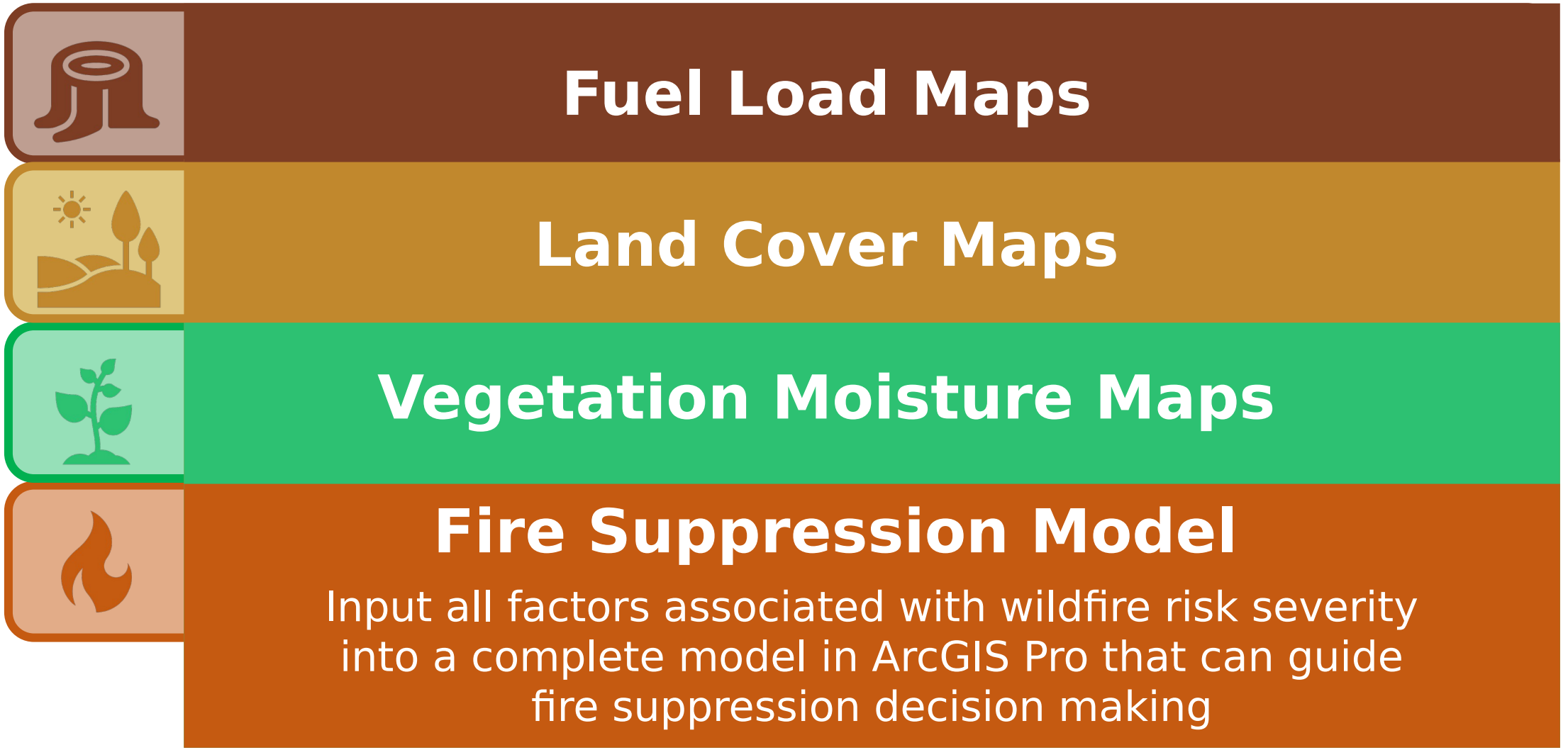
Land Cover Maps

Identify the aspect, slope, elevation, and land cover types across study period

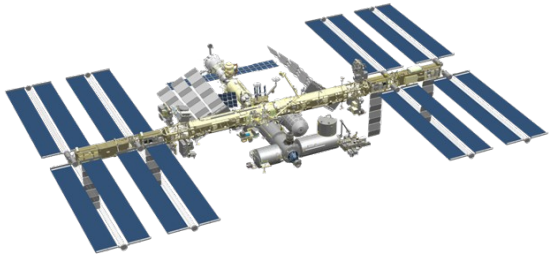
Objectives


Fuel Load Maps
Land Cover Maps
Vegetation Moisture Maps
Utilize high resolution ECOSTRESS data to examine soil and vegetation moisture parameters

Objectives


Fuel Load Maps
Land Cover Maps
Vegetation Moisture Maps
Fire Suppression Model
Input all factors associated with wildfire risk severity into a complete model in ArcGIS Pro that can guide fire suppression decision making

Earth Observation Platforms and Sensors



International Space Station (ISS)- ECOSTRESS

Sentinel 2-A MSI

PlanetScope DOVE

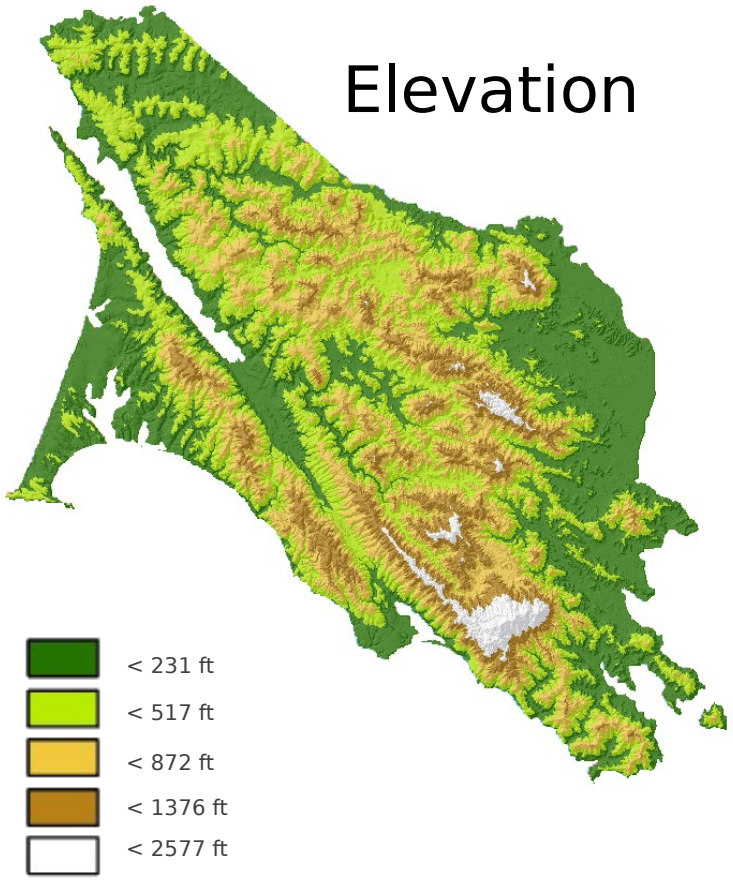
Landsat 7 ETM+ and Landsat 8 OLI & TIRS

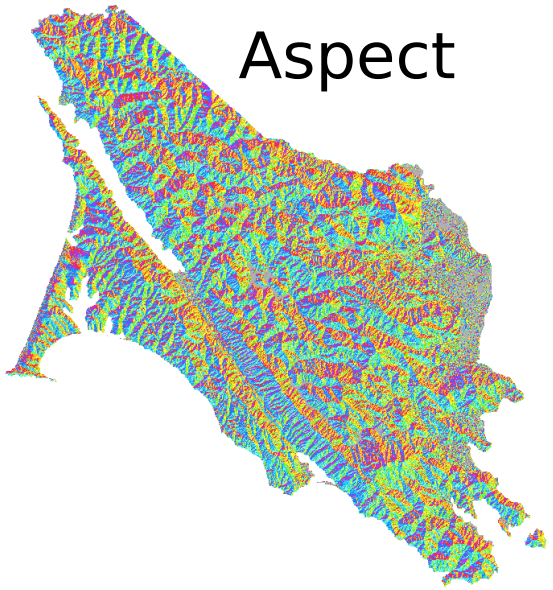
LiDAR

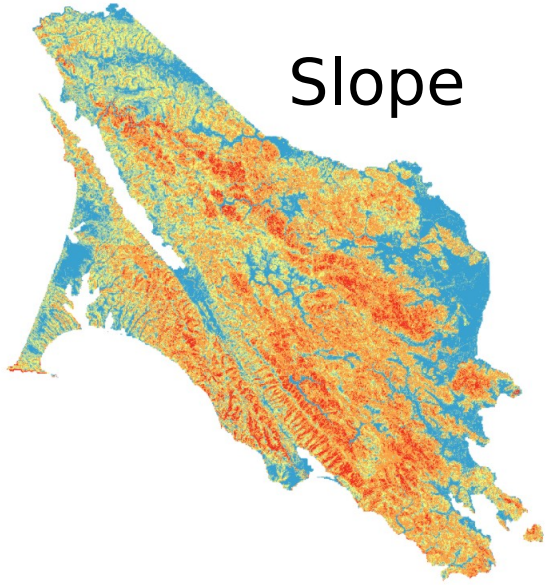
Satellite Image Credits: NASA, Planet Labs PBC

Other Image Credits: Microsoft Powerpoint Icons

Data Processing: Topography







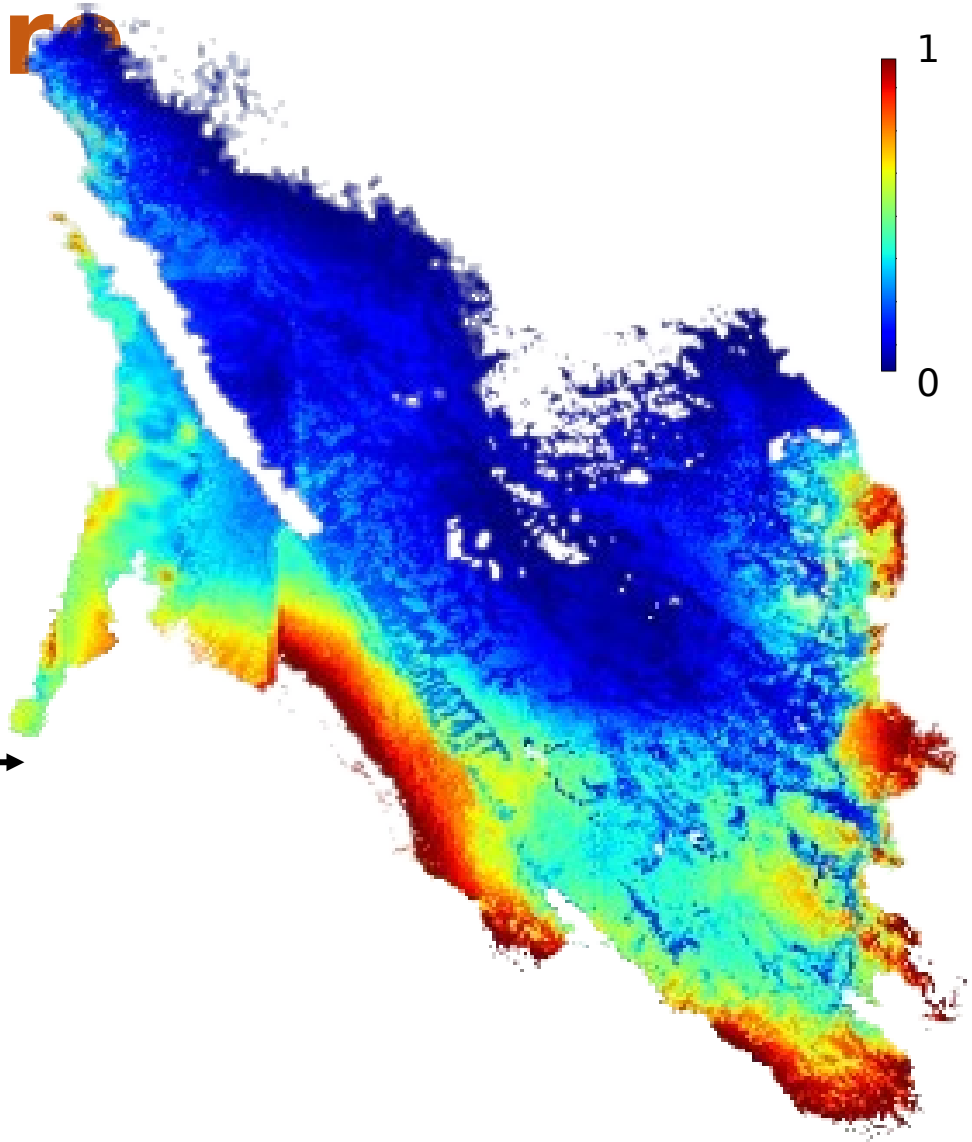
Data Processing: Moisture

ECOSTRESS:

WUE — *Water Use Efficiency*

ESI — *Evaporative Stress Index*

AppEEARS → *Image Processing*

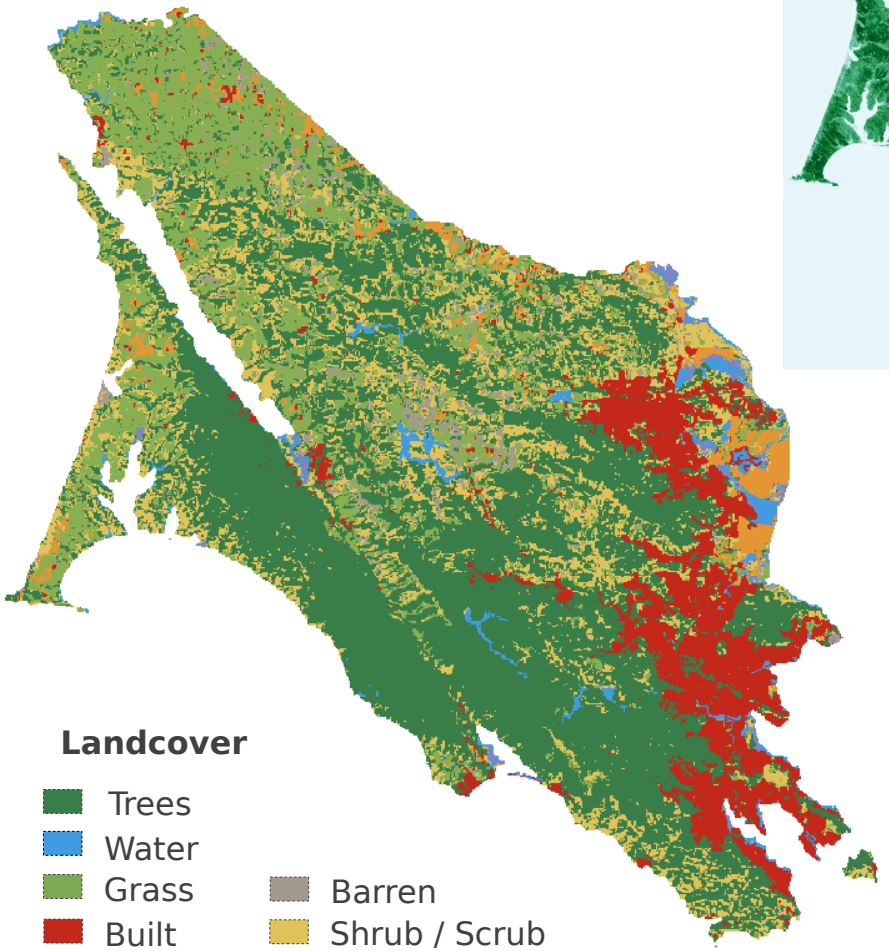


Data Processing: Landcover Fuels

Gather Sentinel-2A images

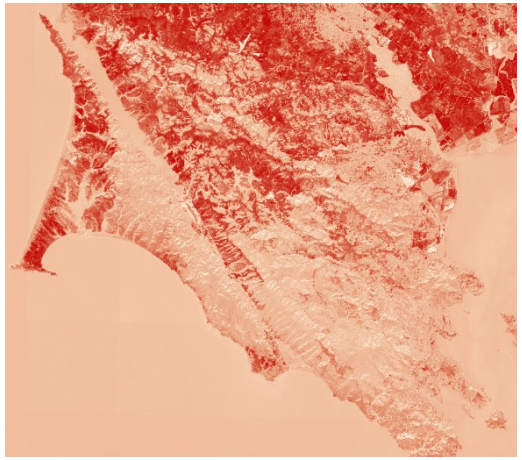
Run Dynamic World code in GEE

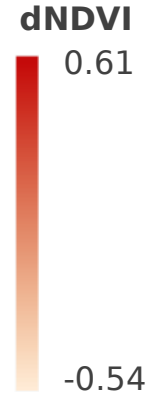
Process annual composites in ArcGIS



Wet season NDVI (mid-November through mid-May)

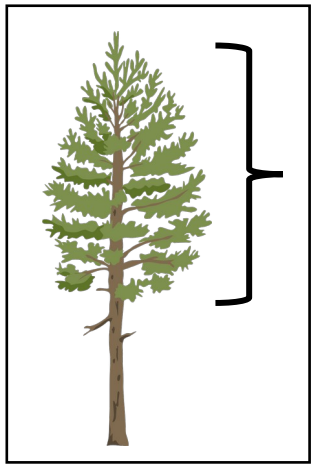
Dry season NDVI (mid-May through mid-



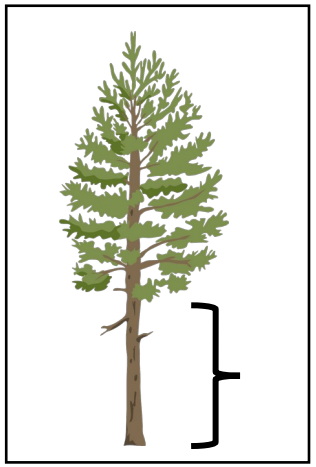


NDVI differential (wet season – dry season)

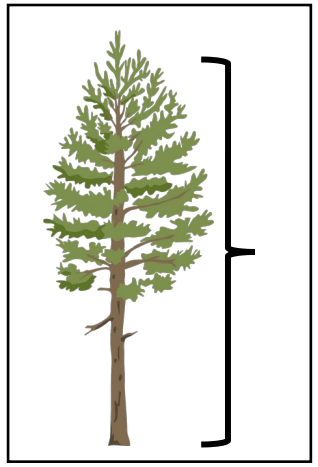
Data Processing: Forest Fuels



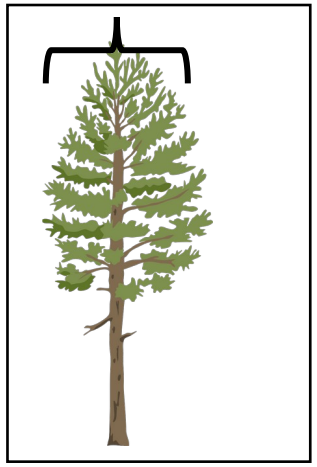
Canopy Bulk Density



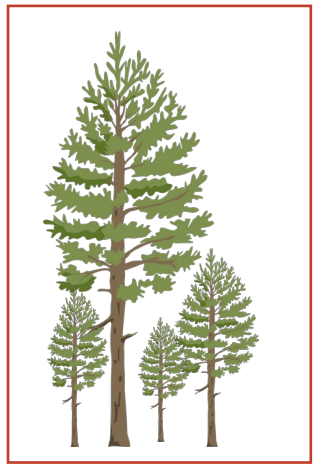
Canopy Base Height



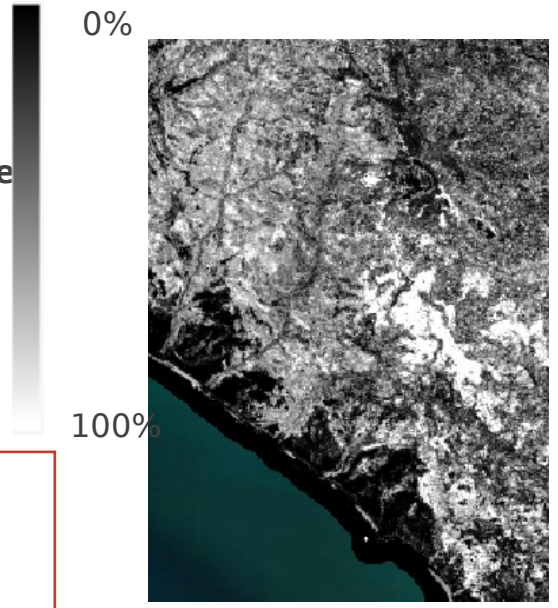
Canopy Height



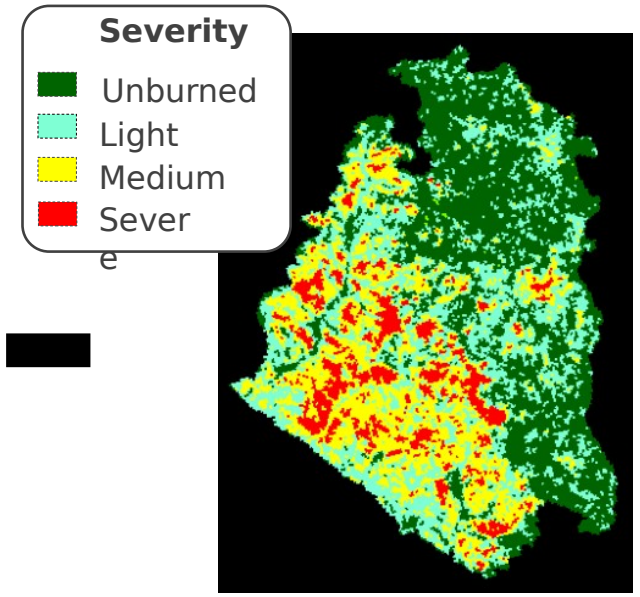
Canopy Cover



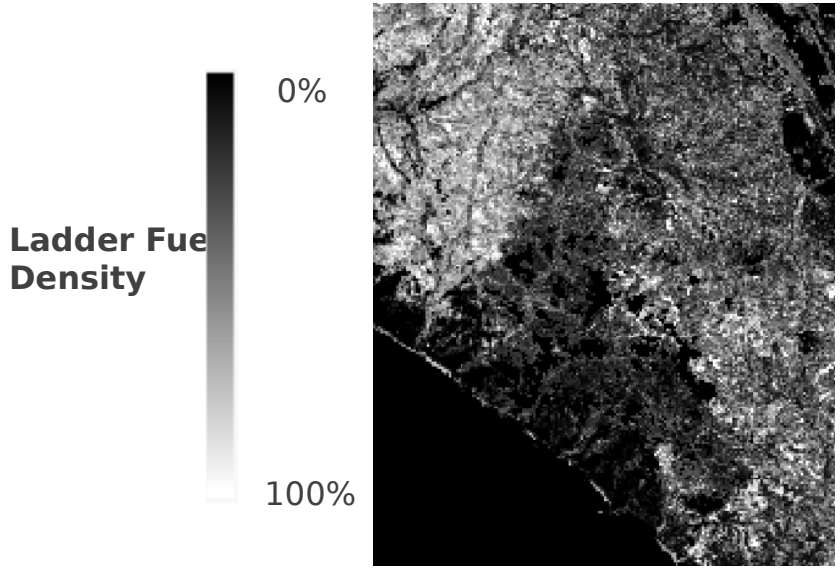
Ladder Fuel Density



Pre-fire ladder fuels



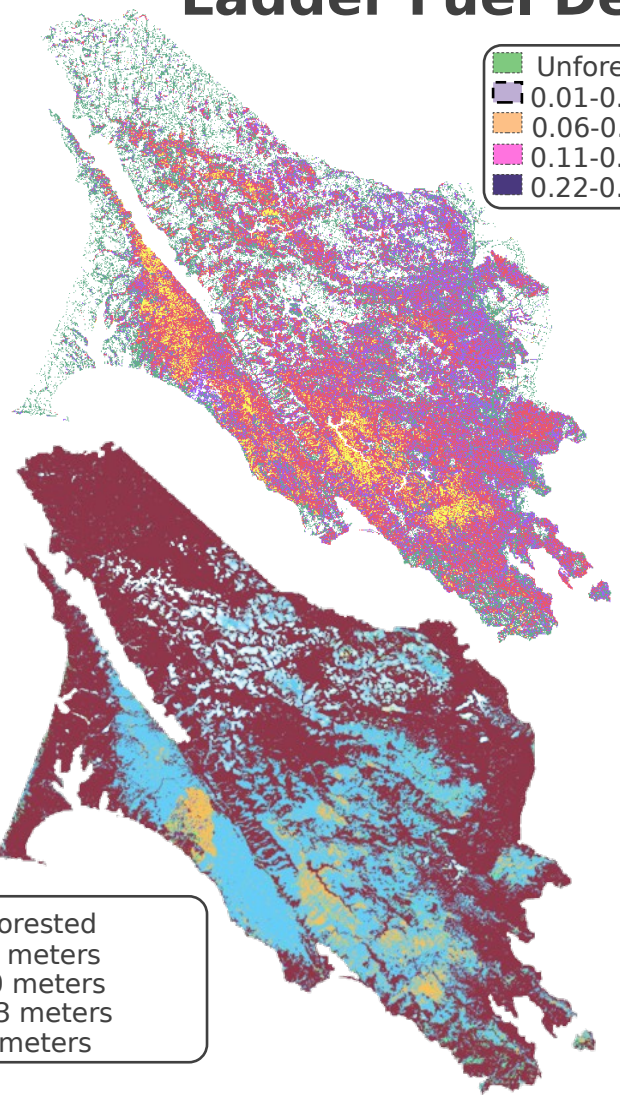
Fire perimeter burn severity



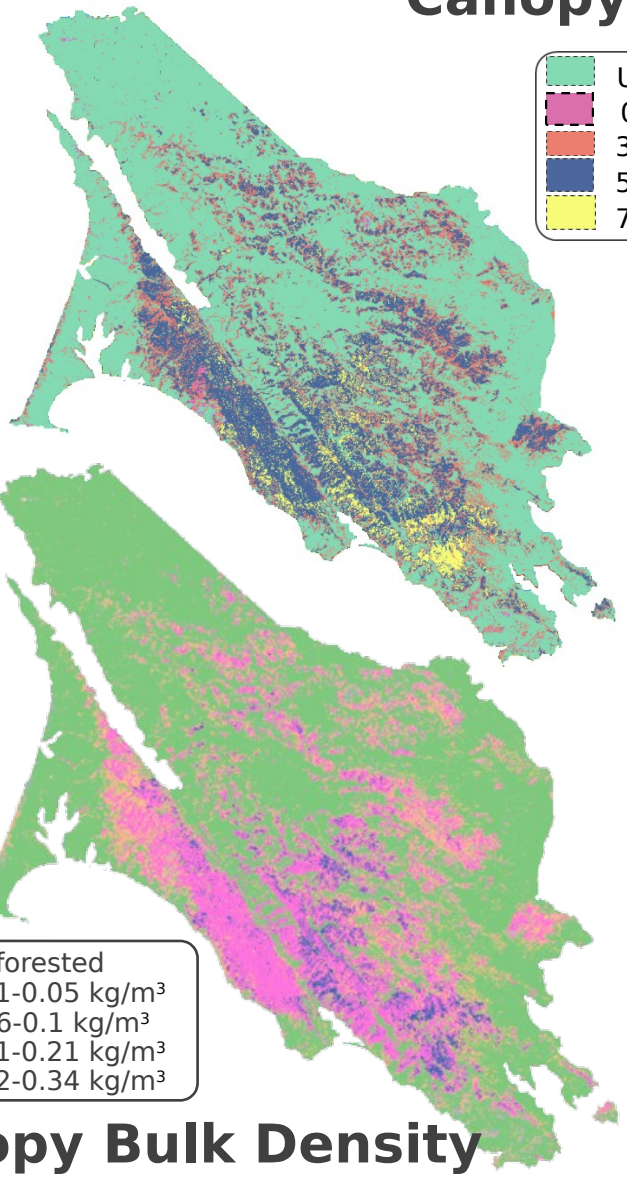
Post-fire ladder fuels

Fuel s

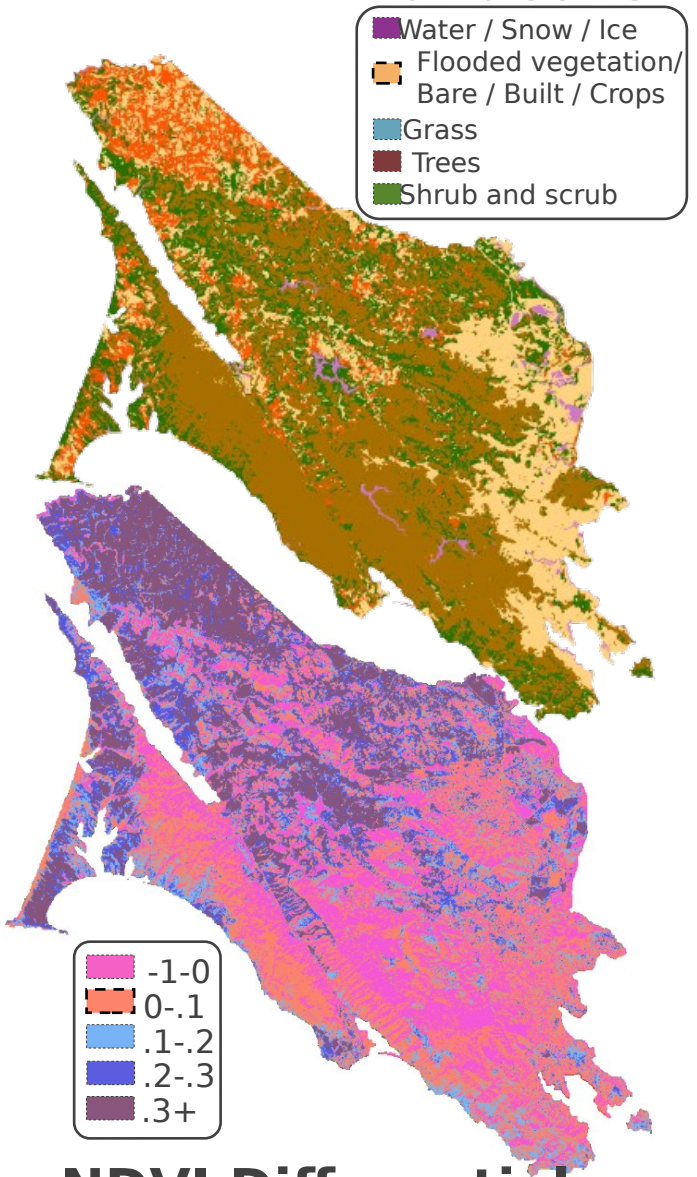
Ladder Fuel Density



Canopy Cover



Landcover

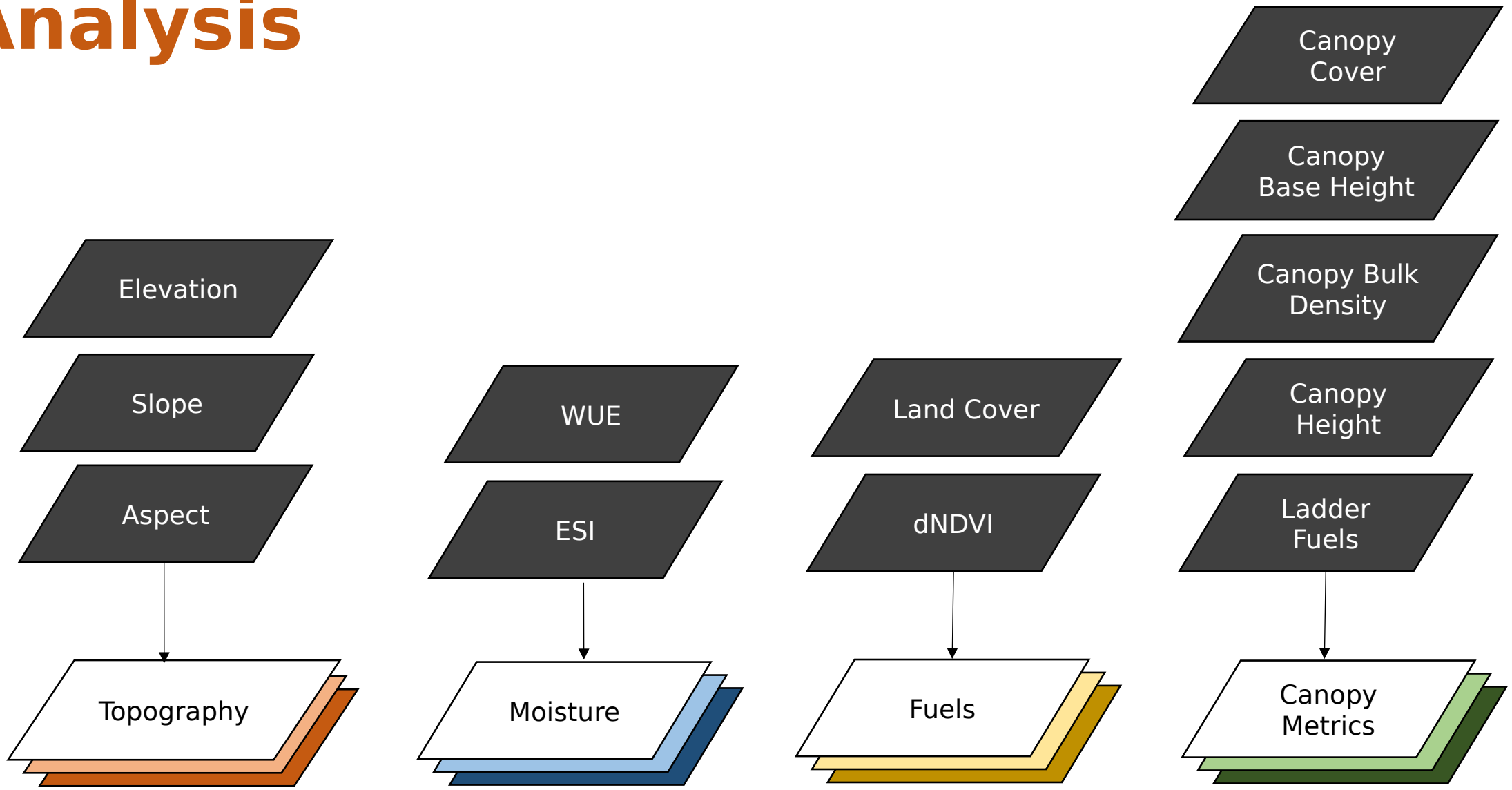


Canopy Base Height

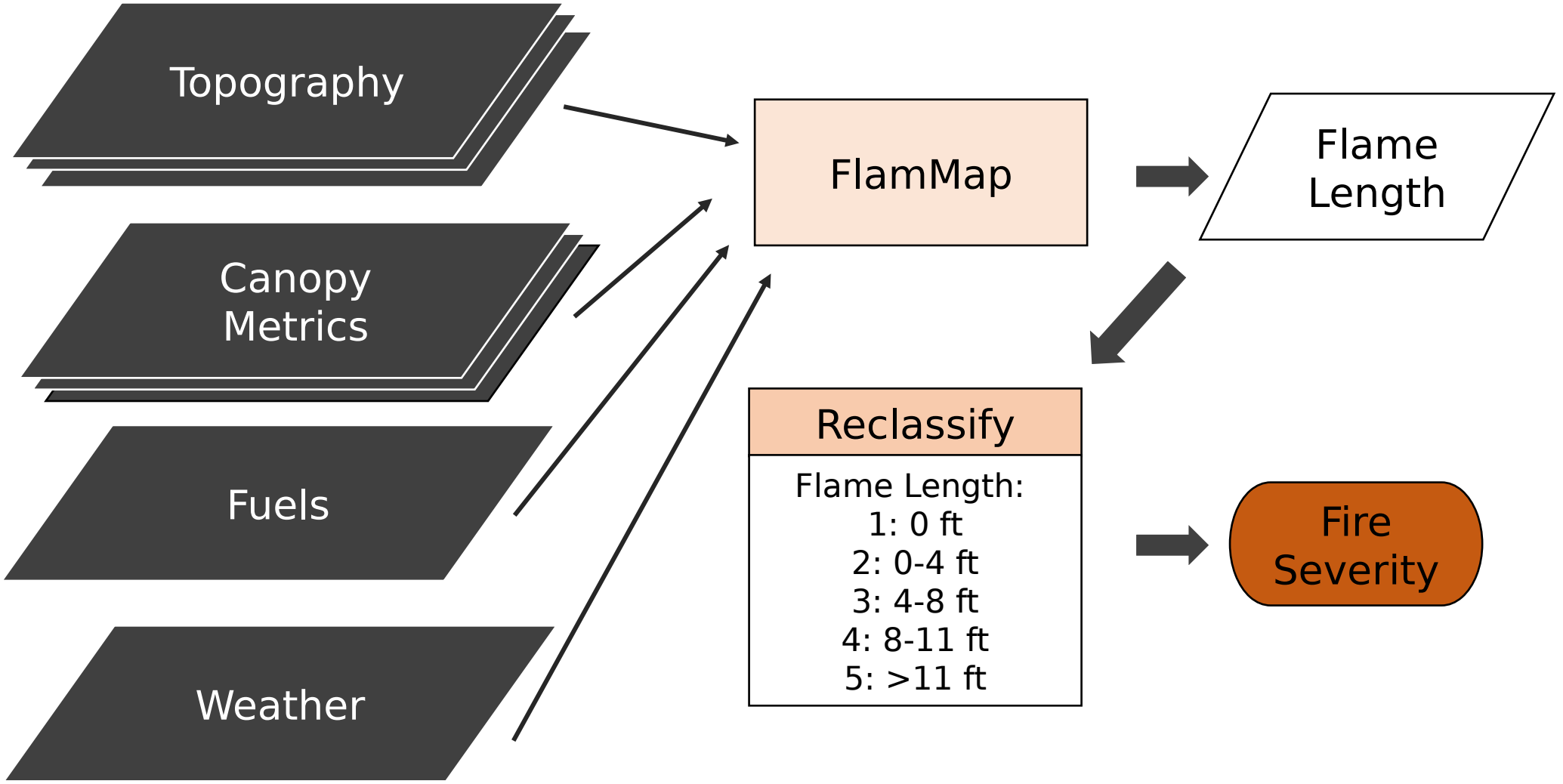
Canopy Bulk Density

NDVI Differential

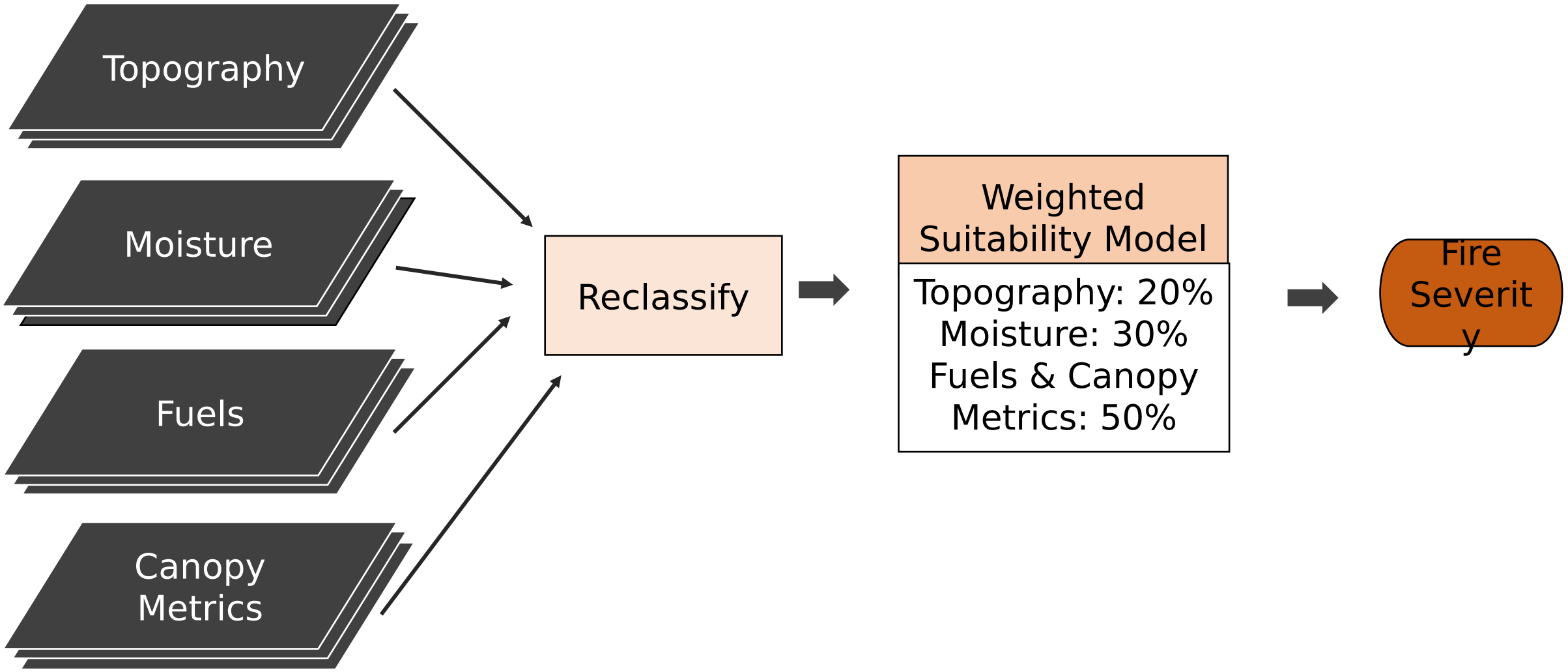
Data Analysis



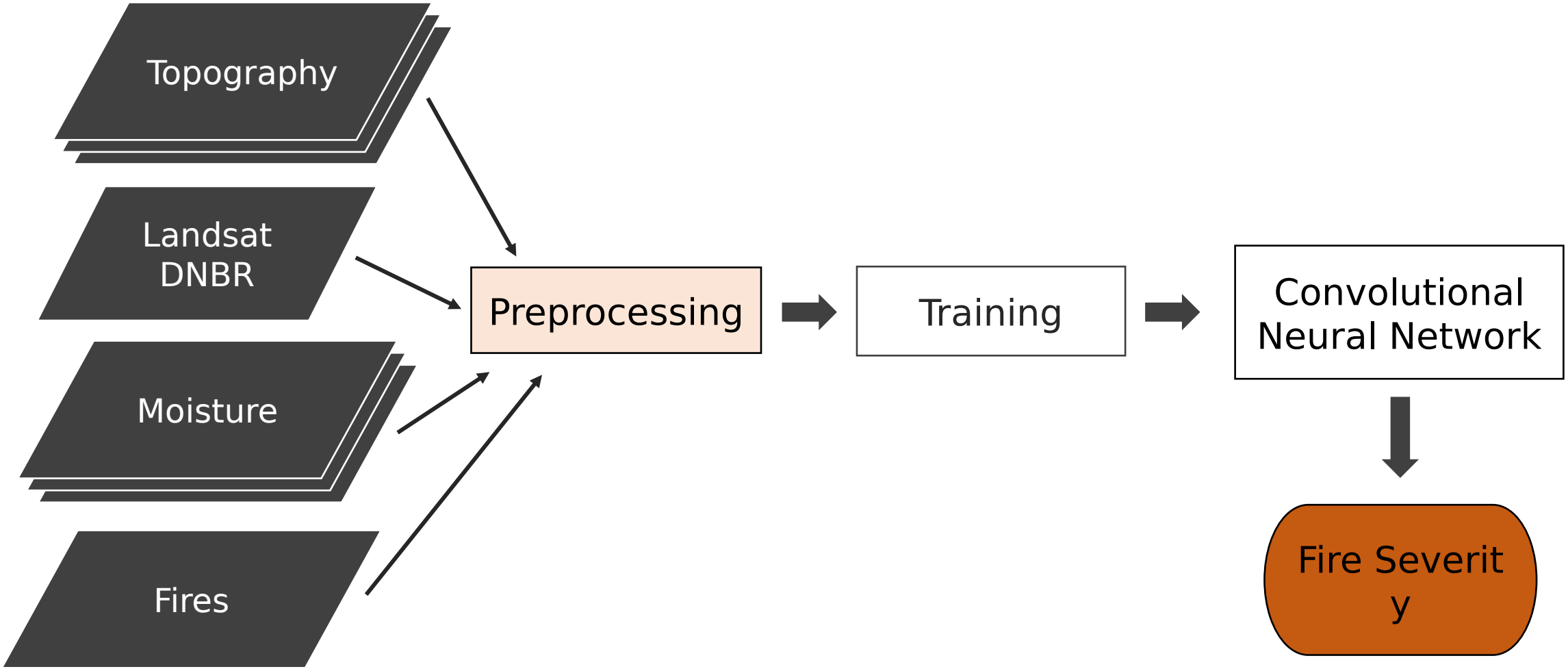
Model 1: FlamMap



Model 2: Suitability

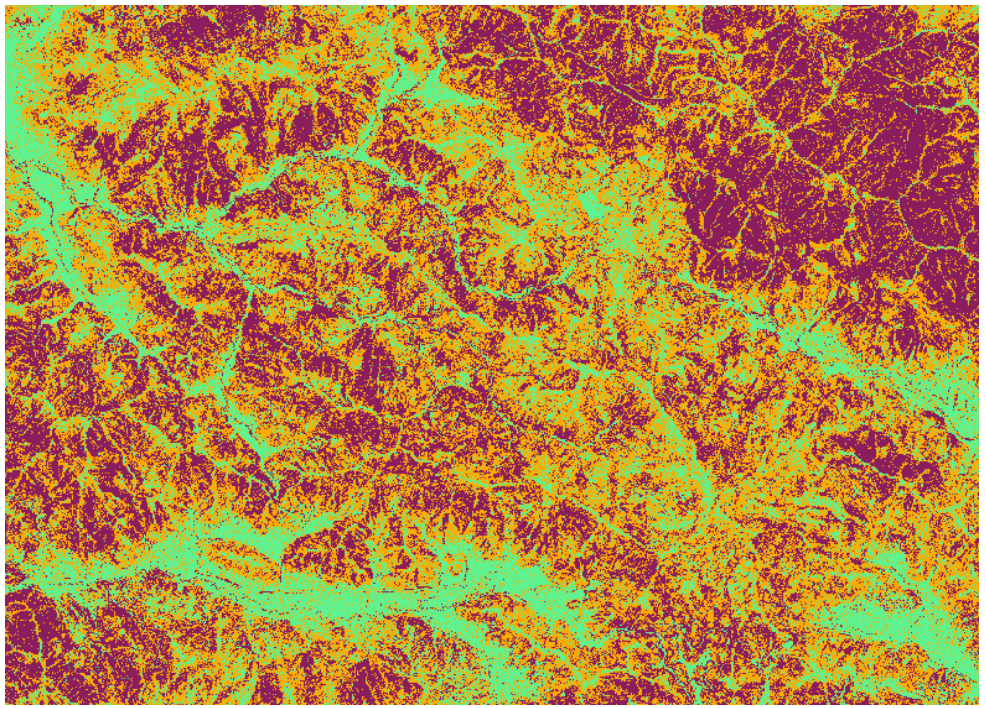


Model 3: Machine Learning



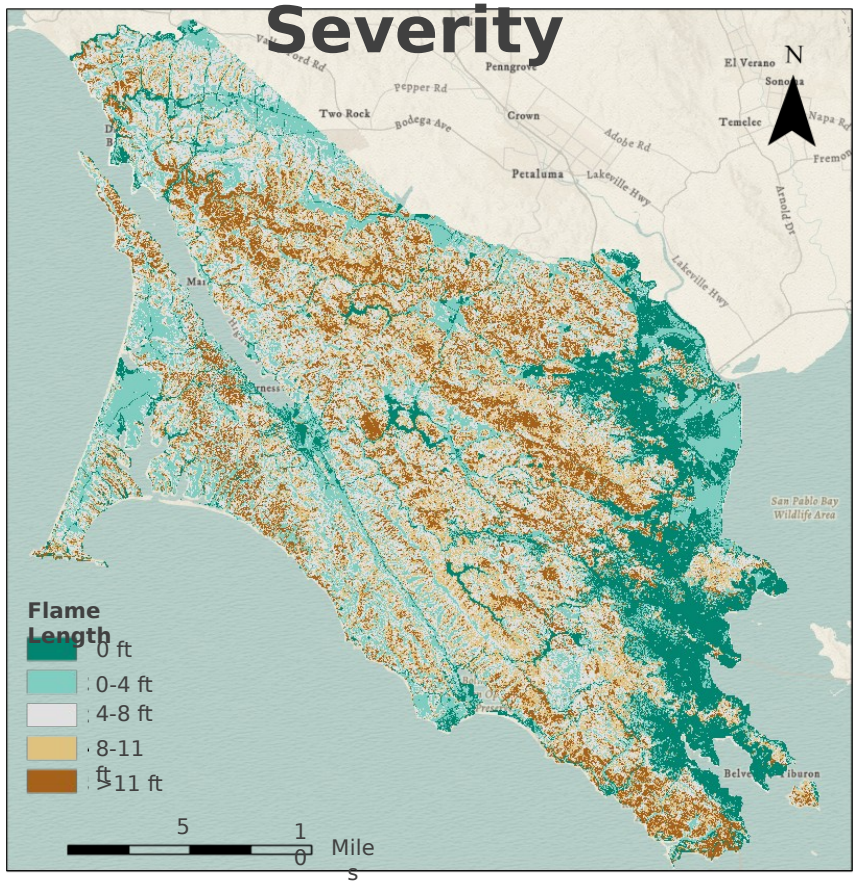
Methodology: Fire Lines

Image Credit: A. J. T. Johnsingh, WWF-India and NCF

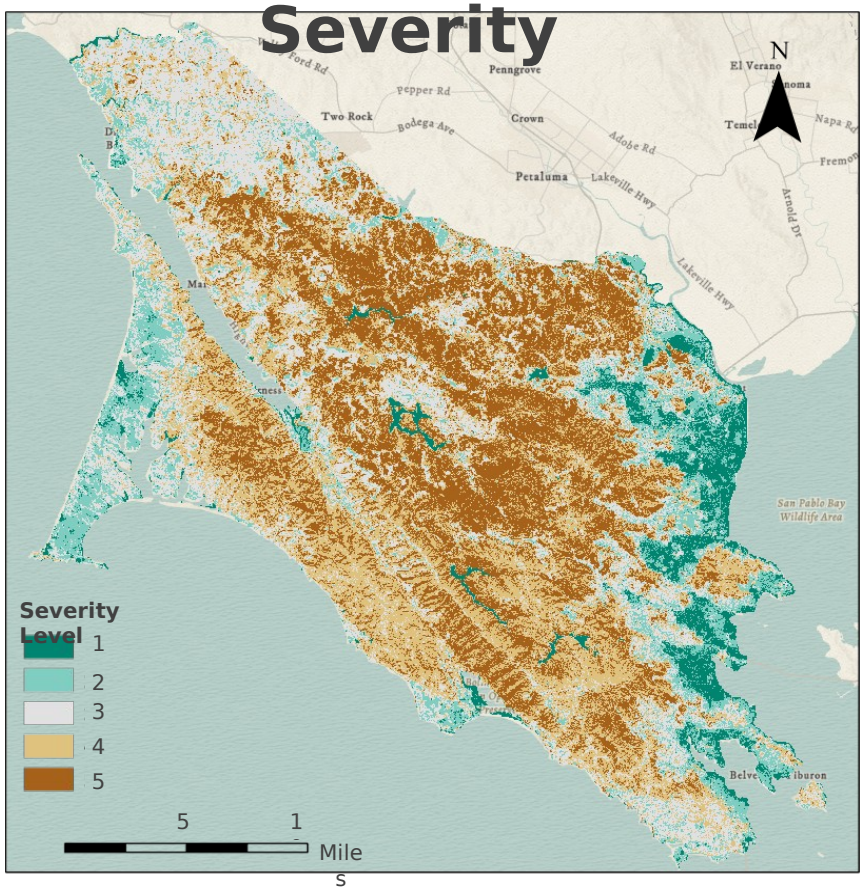


Results: Severity Models

FlamMap Severity

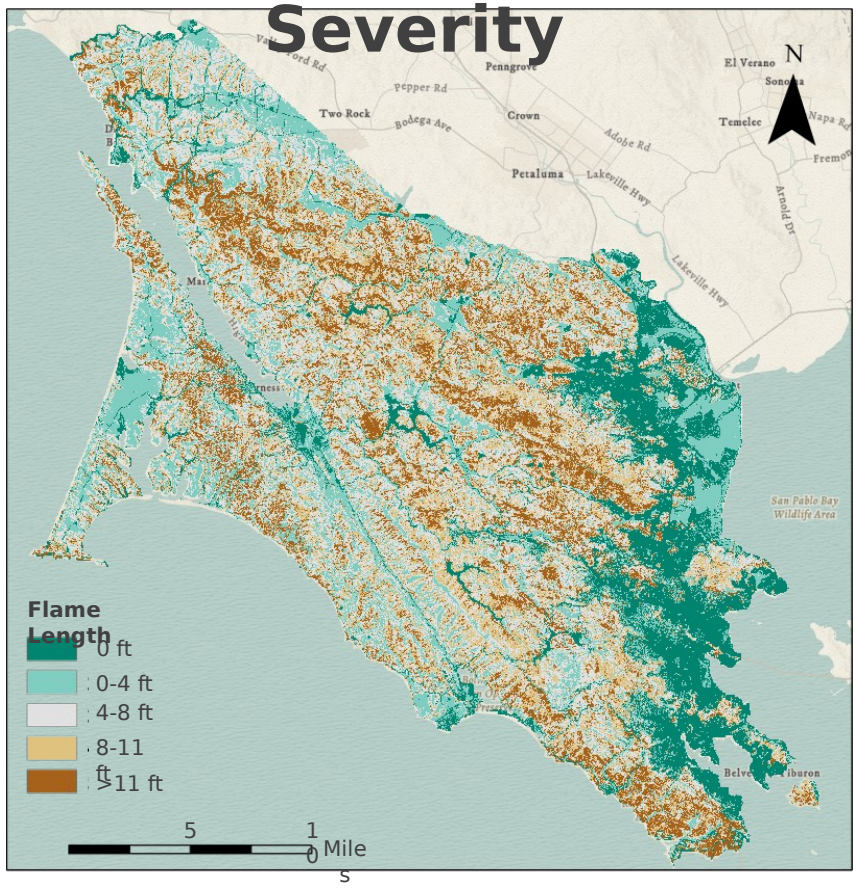


Suitability Severity

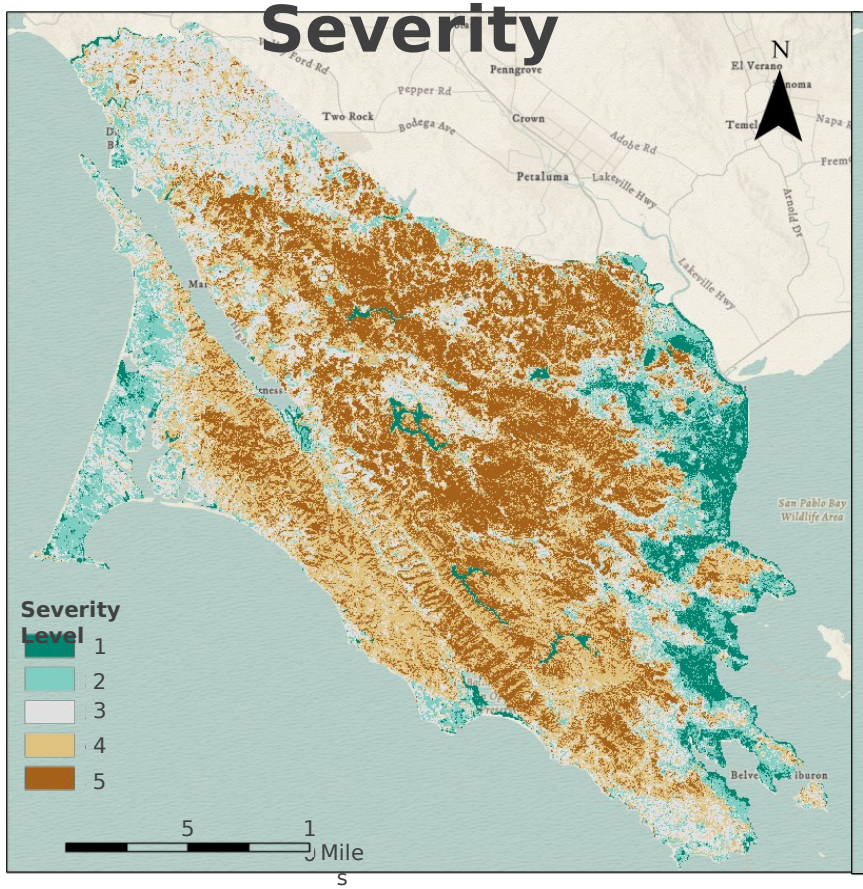


Results: Severity Models

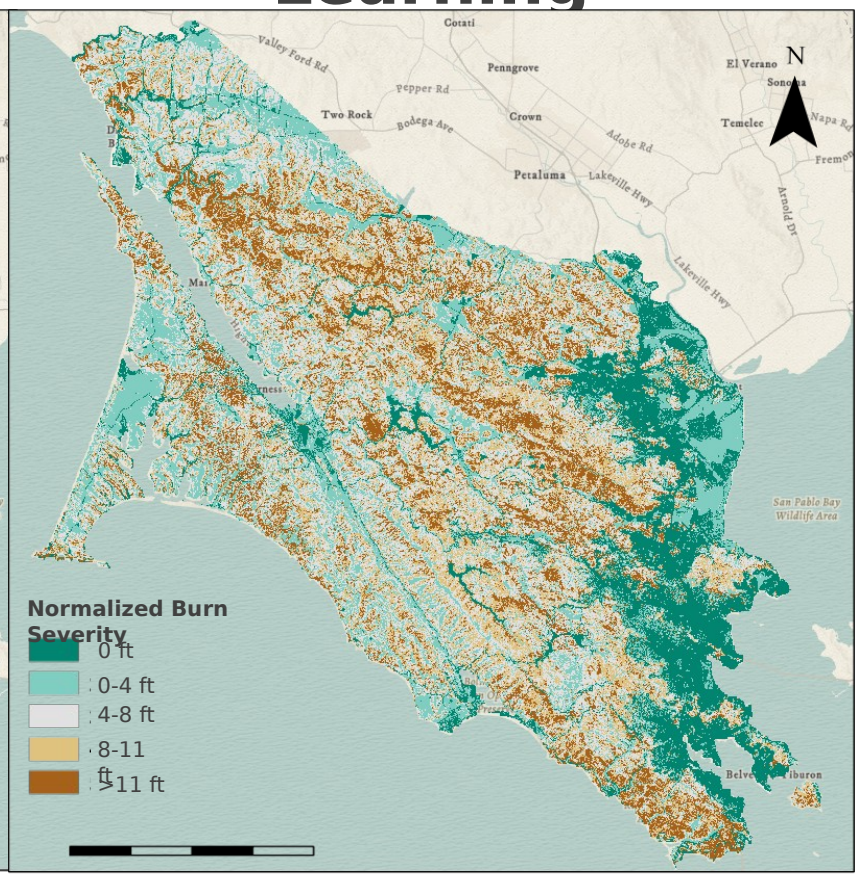
FlamMap Severity



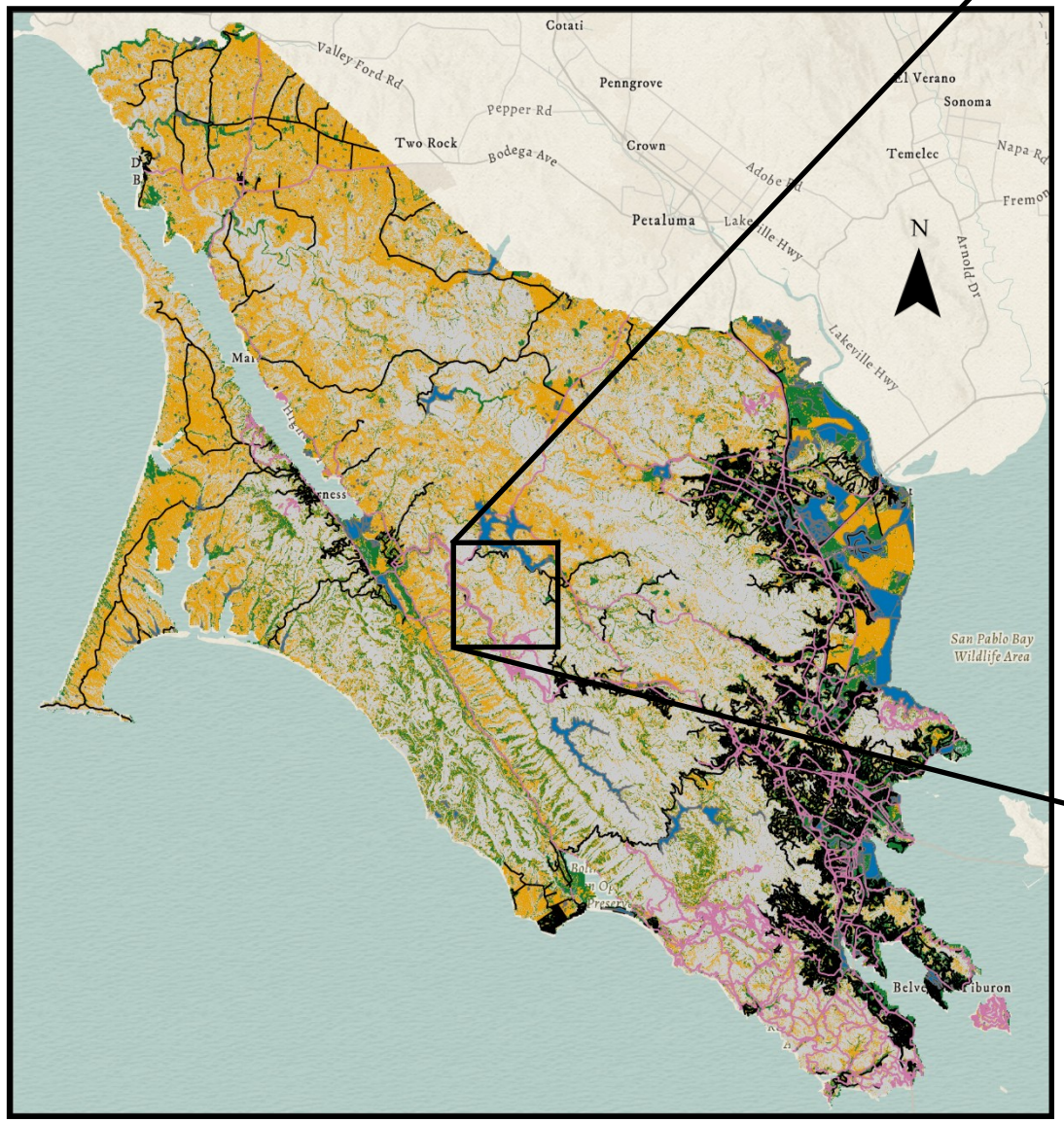
Suitability Severity

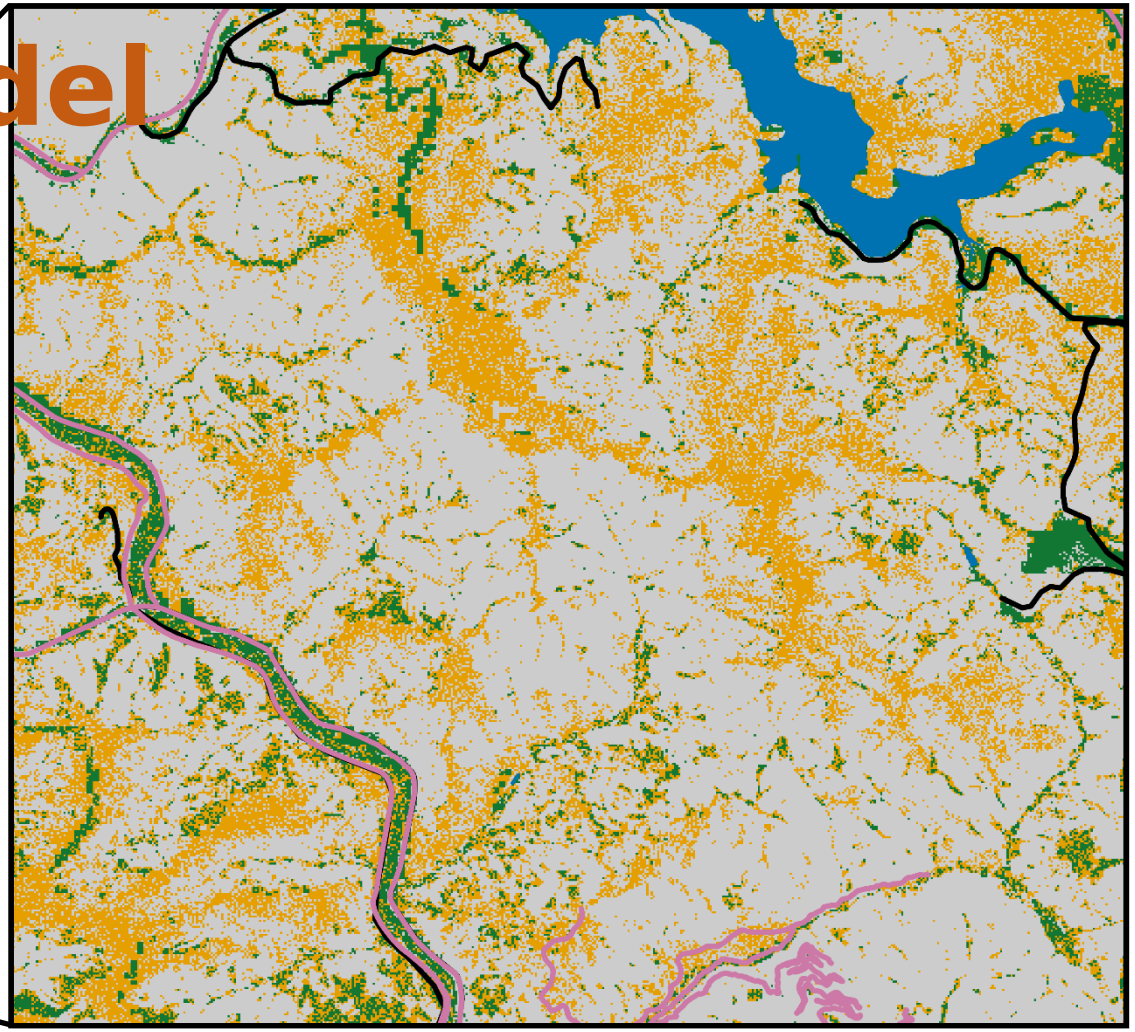


Machine Learning



Results: Fireline Model





1 Mile

Roads

Trails

Water

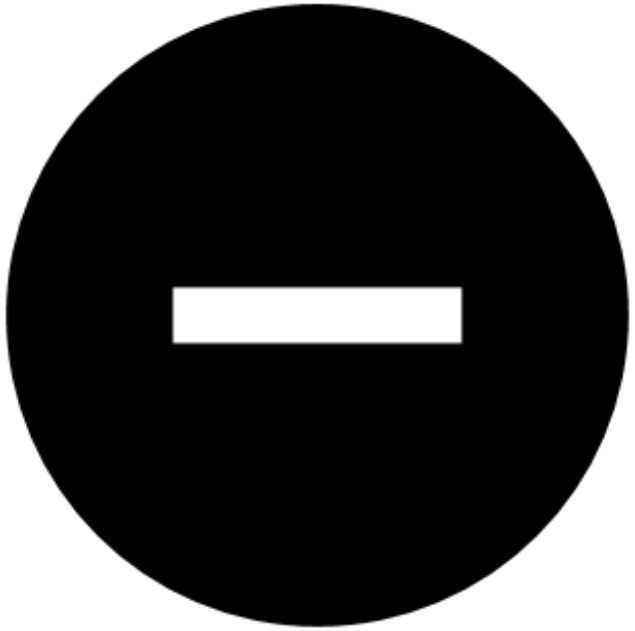
Fireline Potential

Easy

Medium

Difficult

Errors and Uncertainties



Data Limitations

Model Uncertainties

Conclusions

- A fusion of satellite and ground LiDAR data, focused on moisture, fuels, and topography can be used to quantify fire severity in Marin's unique environment of microclimates
- Model comparisons can be used to understand the various algorithms for computing fire severity in relation to a region
- A feasible approach is combining the outputs of the fire severity models with fire line & slope data for the fire line model

Image Credit: Fire Foundry

Future Work

Locate areas for fire lines beyond Marin County

Validate input parameters

Incorporate additional parameters into the fire model

Design a workshop for FIRE Foundry

Acknowledgements

Partners

- **FIRE Foundry**
  - Josh Dimon
- **Marin County Fire Department**
  - Graham Groneman

NASA DEVELOP

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- Dr. Juan Torres-Pérez (NASA Ames Research Center)
- Britnay Beaudry (NASA Ames Research Center)

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